ACCOMMODATION STUDY FOR AN ANEMOMETER ON A MARTIAN LANDER

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Measuring the winds near the surface of Mars as well as their turbulent fluctuations is important to more fully understand the behavior of the boundary layer of Mars. This in turn is important to minimize the risk in landing for future exploration at Mars, but also to understand the interaction between the surface and atmosphere in terms of the transfer of heat, momentum and trace constituents including dust, water and other trace gases. Instrumentation is now becoming available for Mars that can measure not only the mean winds, but also their turbulent fluctuations and also resolving the full 3-D nature of the wind rather than just the horizontal winds (e.g., see Banfield's abstract regarding a Martian Sonic Anemometer). With the instruments becoming available, the question is raised of how best to place such an instrument on a Martian lander or rover to yield the most undisturbed flow measurements in the presence of the lander/rover, and in the case where flow distortions can not be avoided, how to correct for these perturbations.

To address this question, we used computation fluid dynamics to model the boundary layer flow at Mars, as well as the mean and turbulent flow distortions that would be realized at various positions around simplified lander/rover structures. We first tuned our model to match the rough conditions experienced by Mars Pathfinder in terms of the range of roughness lengths and friction velocities seen, although under the assumption of neutral stability. Armed with this, we inserted into the flow a hemispheric lander with radius 1m and a half cube that just fit inside the hemisphere. We investigated the nature and correctability of the flow distortions that resulted from the flow around these simplified lander/rovers at various positions around them. We found that the exact shape of the lander/rover was not very important for ranges greater than 1.2m from the center of the sphere or cube. Presumably these results may then be extrapolated to more complex lander/rovers of similar sizes. We found that the mean flow and the turbulent characteristics of the flow (as expressed in terms of the 6 Reynolds Stresses) were least perturbed when the anemometer was placed at least 1.8m from the center of the spherical lander/rover. Additionally, if the instrument were canted 55 degrees above horizontal the flow distortions were again minimized when considering all possible azimuths for wind direction. Finally, our modeling suggests that the mean and turbulent characteristics of the perturbed flow are correctable to a high degree to yield the equivalent unperturbed flow that would have resulted without the lander/rover present at all when the anemometer placement meets or exceeds this range from the lander/rover center and is placed at 55 degrees elevation. While this study used idealized lander/rovers and neutral stability conditions, we believe it is instructive in a general sense for the placement of anemometers on rovers. It is encouraging that good results were found to be possible with an instrument located only 0.8m from the edge of the lander/rover, simplifying anemometer accommodation on a realistic martian lander.